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METHYL BROMIDE FUMIGATION OF GREENHOUSE PLANTS AT THE U. S. PLANT INTRODUCTION GARDEN, GLENN DALE, MD.

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The use of methyl bromide fumigation to destroy various stages of insects on plants being distributed from the U. S. Plant Introduction Garden, Glenn Dale, Md., has received considerable study during the past year. The interest of the senior author has been to aid the District of Columbia Inspection Service, a unit of the Division of Foreign Plant Quarantines, Bureau of Entomology and Plant Quarantine, which inspects all shipments from this establishment, by extending studies of tolerance of hitherto untested species of plants to methyl bromide fumigation under routine commercial conditions. The junior author was concerned in perfecting the method as part of his regular duties of conditioning plants for distribution from the Plant Introduction Garden. The use of methyl bromide as a plant fumigant is still rather new, and since there is considerable interest in its various applications, especially as regards plant tolerance, and in the use of vault fumigation for the control of greenhouse pests on potted plants, the results presented here may have value to other workers in this field.

Since many of the plants studied were greenhouse-grown ornamentals which would be in active growth when shipped, fumigations were attempted at minimum dosage rates.

The Plant Introduction Garden was faced also with the difficult problem of insect control in its greenhouses, which were occupied by a great number of fairly small lots of many species, of many families, and in all stages of growth, which precluded general use of ordinary greenhouse sprays or fumigants. Because of this situation the studies with methyl bromide included extensive trials designed to test the possibilities of adapting this method to general sanitation of potted plants.

The trial-and-error method was used from the first. A few plants of given lots received test fumigations, and if the trials were successful the remaining plants in these lots were fumigated. The

effect of dosage rates on insect kill was studied in this gross manner, the rates varying during the course of the studies from 2 lbs./120 min.[1/] to 1.5 lbs./120 min. and to 2 lbs./90 min., and finally stabilized at 2.5 lbs./90 min., a rate which seemed to give complete destruction of all stages of insects usually present, under the various conditions encountered in routine fumigation. Other rates were also tried in single tests: 1 lb./120 min., 2 lbs./150 min., and 2.25 lbs./90 min.

Studies were begun in September 1939 with plants removed from greenhouse benches and reset there following fumigation. As information was obtained on the tolerance of certain species, these were fumigated in quantity in a general clean-up effort. By February 1940 sufficient data had been accumulated to permit fumigation of practically all greenhouse plants to be distributed. Dormant field-grown ornamentals also were fumigated and stored in a cold shed until shipment.

All plants were fumigated in a 450-cubic-foot atmospheric vault, which was lined with sheet metal to prevent leakage. The vault was provided with a 10-inch desk fan for circulation and a 12-inch exhaust fan to remove the gas following treatment. The methyl bromide was measured by weight. A thermostatically controlled heater maintained a temperature of approximately 70 degrees F. during fumigation. The plants were loaded in wire-bottomed carriers, which were so arranged as to provide about 110 square feet of shelf space. Since, at the rate of 2.5 lbs./1,000 cu. ft., only 1.25 pounds of methyl bromide (costing about 87 cents) was used per fumigation, the cost per 1,000 plants was relatively low.

Injury appeared to be specific for the plant treated and uniform within that species. Where a given dosage produced leaf burn or defoliation of plants, a repetition of the treatment usually caused comparable results. The type of injury, however, varied on different species. On some, young growth was burned, while on others only mature leaves were effected. On still others no burning occurred but abcission of all mature leaves resulted. In one instance growth was suspended for some time.

Instances of injury were confined to relatively few species, however. A total of several thousand plants of 441 species from widely separated families were fumigated. Of these, 414 species (93.9 percent) were uninjured, while 27 species (6.1 percent) showed various degrees of injury. Only 5 species (1.1 percent) were severely

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1/ The dosage rate is expressed in pounds of methyl bromide per 1,000 cubic feet of space, including the load, for a given period of time. For the sake of brevity and to avoid confusion on the reader's part, it is abbreviated to pounds/minutes. In all tests the temperature was 70 degrees F.

burned. In four of them, Aloe sp., Cardiospermum integerrimum, Fokienia hodginsii, and Guadua sp., the plants were so definitely injured, or such limited numbers were available, that no further tests beyond one- or two-plant trials were attempted. Fuchsia arborescens was badly burned in a first trial, and even slightly burned when the dosage was reduced by half. A further test with 2 lbs./90 min. also produced severe burning, but this same dosage was not injurious when the plants were syringed afterwards and kept in a cool location.

Plants in one species, Melastoma sp., were not burned, but growth stopped after a fumigation in November. A large number treated in February, after new growth had started, were not retarded or otherwise injured. Two species showed various degrees of light burning. Some leaves of Amphicoma arguta were burned in September and November fumigations but not at all in February and April treatments. Cinchona pubescens X officinalis showed an occasional burned tip or lower leaf in one test but no burning in another, and hundreds of plants of a close relative in the same genus were not burned at all.

Six species showed injury to new tip growth. Tips on Desmodium tiliaefolium were generally burned by treatment in September, as were plants of Eupatorium ligustrinum. Cotyledon sp. suffered tip burn on mature leaves. Tips of Plectranthus sp., Psidium guajava, and Theobroma purpureum also were burned.

Fumigation caused burning or dropping of mature leaves in 12 species. Bryophyllum alicise and B. miniatum dropped mature leaves, and B. tubiflorum had some burning of mature leaves. Jacaranda acutifolia was almost defoliated owing to dropping of mature leaves, but no injury resulted to new foliage in later tests. Five species of Kalanchoe had burning or loss of lower leaves. Four plants of K. synsepala died following fumigation, but four plants of the same species from another source fumigated at the same time were uninjured. Repeated tests with Pittosporum glabratum caused a loss of mature leaves but no injury to other plant parts. Two species, Oncoba routledgii and Skimmia japonica veitchii, were completely defoliated without any apparent burning of the foliage.

Light tip burning and the loss of mature leaves did not seem to be significantly detrimental in most cases.

Moisture conditions apparently exercised considerable influence on plant reaction. In one instance plants of Fuchsia arborescens were severely burned by fumigation when the relative humidity of the vault remained at 40-50 percent. Plants of the same species were uninjured by an equal dosage when atmospheric humidity was kept at or near saturation. Plants in dry soil tended to show more injury than those in moist soil. Because of these observations a

high relative humidity was maintained in the fumigating vault by soaking all pots preceding treatment, and augmenting the humidity by means of water dripped on a quantity of excelsior in a wire basket placed in front of the heater which maintained the vault tempterature.

It was observed also that conditions during the postfumigation period influenced the ultimate reaction of the plants. In experimental tests fumigated plants kept in rapid air currents showed more injury than similar plants in a protected position, in rather direct proportion to the length of time so exposed. For this reason the exhaust period was shortened to only the minimum period necessary to free the vault of methyl bromide, usually 20 to 30 minutes.

As stated previously, the dosage rate was varied. Practically all dosages used produced extremely high mortality of the insects present. Aphids and whiteflies were killed by doses lower than those required for thrips, mealybugs, soft scales, and red spiders. Since occasional individuals apparently survived fumigations with 2 lbs./90 min., the rate of 2.5 lbs./90 min. was finally adopted. Advances in the general knowledge of plant tolerance and the improvement of factors influencing successful fumigation showed that this dosage would be tolerated by a large majority of the species of plants concerned.

The species of plants fumigated are given in the following table. Absence of a statement concerning injury signifies absence of injury. It must be remembered that these treatments were generally performed at dosages as near as possible to the minimum required for insect control under the particular set of conditions existing at the Plant Introduction Garden. Slightly higher or lower dosages might be required elsewhere to effect insect destruction in a different physical set-up, and likewise plant tolerance might be expected to vary under different conditions.

Table 1.-- Plants fumigated with methyl bromide at the U. S. Plant Introduction Garden, Glenn Dale, Md., 1939-40. Absence of a statement concerning injury signifies absence of injury.

Plant name	Treatment: Dosage, Lbs.	Treatment: Duration, Min.	Number of plants	State of growth	Months tested	Remarks
Abelia "Edward Goucher"	2.5	90	1,300	active	Oct.-Feb.	Also uninjured by 4 lbs./150 min.
Agastache rugosa (Finch. & Mey.) Kuntze	2.5	90	560	do.	Jan.-Mar.	
Agastache rupestris (Greene) Standl.	2.5	90	1,000	do.	Sept.-Mar.	
Agastache sp.	2.5	90	300	dormant	Feb.-Mar.	
Agave parviflora Torr.	2	90	30	active	Nov.	
Agave Schottii Engelm.	2	120	2	do.	Sept.	
Albizzia Thorelii Pierre	2.5	90	110	do.	Nov.-Jan.	
Alnus sp.	2.5	90	510	dormant	Dec.	
Aloe andringitrensis Perrier	2	120	2	active	Sept.	
Aloe antandroi (Decary) Perrier	2	90	125	do.	Nov.	
Aloe brevifolia depressa (Haw.) Baker	1	120	1	do.	Nov.	
Aloe Davyana Schoenl.	2	120	1	do.	Sept.	
Aloe Eru erecta Hort.	1	120	1	do.	Nov.	
Aloe grandidentata Salm-Dyck	1	120	1	do.	Nov.	

Table 1.--Continued.

Plant name	Treatment: Dosage, Lbs.	Treatment: Duration, Min.	Number of plants	State of growth	Months tested	Remarks
Aloe Krapohliana Marloth	1	120	1	active	Nov.	
Aloe latifolia Haw.	1	120	1	do.	Nov.	
Aloe longibracteata Pole Evans	1	120	1	do.	Nov.	
Aloe pretoriensis Pole Evans	1	120	1	do.	Nov.	
Aloe rubroviolacea Schweinf.	2	90	35	do.	Nov.	
Aloe Schimperi Tod.	1	120	1	do.	Nov.	
Aloe succotrina Lam.	1	120	1	do.	Nov.	
Aloe supralaevis Haw.	1	120	1	do.	Nov.	
Aloe tenuior Haw.	1	120	1	do.	Nov.	
Aloe Thorncroftii Pole Evans	2	120	1	do.	Oct.	
Aloe vaombe Decorse	1	120	1	do.	Nov.	
Aloe spp.	2	120	4	do.	Sept.	Four species.
Aloe sp.	2	120	1	do.	Sept.	Severe burning.
Aloe spp.	1	120	4	do.	Nov.	Four species.
Alonsoa acutifolia Ruiz & Pav.	2	90	303	do.	Nov.- Dec. Jan.-Feb.	

Table 1.--Continued.

Plant name	Treatment: Dosage, Lbs.	Treatment: Duration, Min.	Number of plants	State of growth	Months tested	Remarks
Alonsoa acutifolia Ruiz & Pav.	2.5	90	350	active	Mar.	
Amphicome arguta Royle	2	120	2	do.	Sept.	Some burning on lower leaves.
Do.	1.5	120	400	do.	Nov.	Few leaves burned.
Do.	2	90	70	do.	Feb.	
Do.	2.5	90	200	do.	Apr.	
Amygdalus persica L.	2.25	90	300	dormant	Feb.	
Ananas ananassoides (Baker) L. B. Smith	1	120	2	active	Nov.	
Argania sideroxylon R & S.	2	90	1	do.	Feb.	
Aristolochia spp.	2	90	125	do.	Sept.-Feb.	Two species.
Babiana ringens (L.) Ker	2	90	5	do.	Feb.	
Bactris sp.	2	90	32	do.	Feb.	
Do.	2.5	90	50	do.	Mar.	
Bauhinia Godefroyi Gagnep.	2	90	121	do.	Nov.	Refumigated in Jan.
Bauhinia saigonensis Pierre	2	90	102	do.	Nov.	Do.
Bauhinia sp.	2	90	22	do.	Nov.-Feb.	
Do.	2.5	90	100	do.	Mar.	

Table 1.--Continued.

Plant name	Treatment: Dosage, Lbs.	Treatment: Duration, Min.	Number of plants	State of plants	Months tested	Remarks
Beloperone comosa Nees	2	90	65	active	Sept.-Nov.	
Berberis spp.	2	120	1,445	do.	Oct.	Two species.
Bergenia pacifica Komar.	2	120	1	do.	Oct.	
Bergenia purpurascens (Hook. f. & Thoms.) Engl.	2.5	90	50	dormant	Mar.	
Bergenia sp.	2.5	90	50	do.	Mar.	
Betula atrata Domin	2	120	600	do.	Dec.	
Betula utilis D. Don	2	120	1,000	do	Dec.	
Betula spp.	2	120	573	do.	Dec.	Five species.
Bornoa crassispatha (Mart.) O. F. Cook	2	90	50	active	Feb.	
Do.	2.5	90	60	do.	Mar.	
Bryophyllum Aliciae (R. Hamet) Berger	2	120	5	do.	Sept.	Mature leaves lost.
Do.	2	90	1	do.	Nov.	
Bryophyllum miniatum (Hilsenb. & Boj.) Berger	2	120	255	do	Sept.-Oct.	Mature leaves lost.
Do.	2	90	1	do.	Nov.	Do.
Bryophyllum tubiflorum Haw.	2	90	3	do.	Nov.	Lower leaves burned.

Table 1.--Continued.

Plant name	Treatment: Dosage, Lbs.	Treatment: Duration, Min.	Number of plants	State of growth	Months tested	Remarks
Bryophyllum spp.	2	120	63	active	Sept.	Two species.
Buddleia sp.	2	90	855	do.	Nov.	
Do.	2.5	90	428	do.	Jan.	
Cactus sp.	2	90	27	do.	Nov.	
Calceolaria gracilis H. B. K.	2.5	90	3	do.	Apr.	
Camellia cuspidata (Kocks) Veitch	2	90	2	do.	Nov.	
Camellia japonica L.	2	90	1	do.	Nov.	
Carallume lutea N. E. Br.	2	90	6	do.	Nov.	
Cardiospermum integerrimum Radlk.	2	90	2	do.	Jan.	Severe burning and defoliation.
Do.	2.25	90	2	do.	Jan.	Do.
Carmichaelia grandiflora (Benth.) Hook.f.	1.5	120	2	do.	Nov.	
Do.	2	90	150	do.	Nov.	
Do.	2.5	90	143	do.	Jan.	
Carmichaelia grandiflora divaricata Kirk	1.5	120	3	do.	Nov.	
Do.	2	90	150	do.	Nov.	

Table 1.--Continued.

Plant name	Treatment: Dosage, Lbs.	Treatment: Duration, Min.	Number of growth	State of growth	Months tested	Remarks
Carmichaelia odorata Colenso	1.5	120	3	active	Nov.	
Do.	2	90	95	do.	Nov.	
Do.	2.5	90	150	do.	Mar.	
Ceanothus "Gloire des Plantiers"	2	120	2	do.	Oct.	
Ceanothus sp.	2	120	1	do.	Oct.	
Celastrus Loesoneri Rehd. & Wils.	2	120	88	do	Sept.-Dec.	
Celtis koraiensis Nakai	2	120	27	dormant	Dec.	
Centaurium umbellatum Gilib.	2	90	10	active	Feb.	
Cestrum sp.	2	90	15	do.	Dec.	
Chamaedorea spp.	2.5	90	535	do.	Apr.	Two species.
Cinchona officinalis L.	2	90	2,077	do.	Nov.-Feb.	
Cinchona pubescens Vahl x officinalis L.	2	90	84	do.	Jan.	Occasional tip burn and lower leaf burn.
Do.	2,25	90	4	do.	Jan.	
Do.	2.5	90	114	do.	Jan.	
Cinchona spp.	2.5	90	3,200	do.	Apr.	Three species.

Table 1.--Continued.

Plant name	Treatment: Dosage, Lbs.	Treatment: Duration, Min.	Number of plants	State of growth	Months tested	Remarks
Citrus spp.	2	150	3	active	Sept.	Two species.
Do.	2	90	3	do.	Mar.	Three species.
Coleus Frederici G. Taylor	2	120	2	do.	Sept.	
Convolvulus sp.	2	90	67	do.	Apr.	
Coriaria sp.	2	120	50	do.	Dec.	
Do.	2	90	60	do.	Feb.	
Do.	2.5	90	1,000	do.	Mar.	
Cornus Kousa chinensis Osborn	2	120	2	do.	Oct.	
Cotoneaster uniflora Bunge	2	120	1	do.	Oct.	
Cotoneaster spp.	2	90	258	do.	Nov.	Three species.
Cotyledon umbilicus L.	2	120	1	do.	Sept.	
Cotyledon sp.	2	120	25	do.	Sept.	Tips of mature leaves burned.
Crassula multicava Lem.	2.5	90	10	do.	Dec.	
Crassula perfoliata L.	2	90	33	do.	Nov.	
Crataegus sp.	2	120	43	dormant	Dec.	

Table 1.--Continued.

Plant name	Treatment: Dosage, Lbs.	Treatment: Duration, Min.	Number of plants	State of growth	Months tested	Remarks
Cynanchum spp.	2	90	19	active	Nov.	Two species.
Davisia involucrata Baill	2	120	297	dormant	Dec.	
Derris elliptica (Wamb.) Benth.	2	90	21	active	Nov.-Dec. Jan.-Feb.	
Derris malaccensis Prain	2	90	14	do.	Nov.-Feb.	
Desmodium gyroides DC	2	90	1	do.	Nov.	
Desmodium tiliaefolium (D. Don) G. Don	2	120	2	do.	Sept.	
Do.	2	150	96	do.	Sept.	Tips injured quite generally.
Do.	1.5	120	129	do.	Nov.	
Do.	2	90	52	do.	Jan.	
Do.	2.25	90	108	do.	Jan.	
Deutzia pilosa Rehd.	2	120	9	dormant	Dec.	
Deutzia scabra candidissima Rehd.	2	120	6	do.	Dec.	
Deutzia spp.	2	120	937	do.	Oct.-Dec. Jan.	Eleven varieties.
Deutzia spp.	2.25	90	60	do.	Feb.	Two varieties.

Table 1.--Continued.

Plant name	Treatment: Dosage, Lbs.	Treatment: Duration, Min.	Number of plants	State of growth	Months tested	Remarks
Diospyros sp.	2	120	1	active	Sept.	
Do.	2	90	4	dormant	Jan.	
Drimiopsis sp.	2	90	24	active	Jan.	
Dyckia frigida (Linden) Hook. f.	2	90	30	do.	Nov.	
Erica cinerea coccinea Bean	2.25	90	85	do.	Feb.	
Eupatorium ligustrinum DC	2	120	229	do.	Sept.	Tip burn on very youngest.
Do.	2	90	71	do.	Nov.-Jan.	
Do.	2.5	90	200	do.	Mar.-Apr.	
Eurya acuminata DC	2.5	90	93	do.	Jan.	
Exochorda grandiflora Lindl.	2	120	62	dormant	Jan.	
X Fatshedera Lizei Guill.	2	90	1	active	Dec.	
Ferocactus gracilis H. E. Gates	2	120	125	do,	Oct.	
Ferocactus peninsulae (Weber) Britt. & Rose	2	120	75	do.	Sept.	
Ferocactus rectispinus (Engelm.) Britt & Rose	2	120	11	do.	Sept.	

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Table 1.--Continued.

Plant name	Treatment: Dosage, Lbs.	Treatment: duration, Min.	Number of plants	State of growth	Months tested	Remarks
Ferocactus viridescens (T. & C.) Britt. & Rose	2	120	200	active	Sept.	
Ferocactus viscainensis H. E. Gates	2	120	89	do.	Sept.	
Ficus Kerstingii Warb.	2.5	90	2	do.	Jan.	
Filipendula sp.	2	90	9	do.	Feb.	
Fokienia Hodginsii (Dunn) Henry & Thomas	2.25	90	1	do.	Feb.	Severe burn.
Fraxinus Greggii A. Gray	2	90	87	active	Nov.	
Fuchsia arborescens Sims	2	120	1	do.	Sept.	All foliage badly burned but plant released.
Do.	1	120	305	do.	Oct.-Nov.	Occasional burn.
Do.	2	90	91	do.	Nov.-Dec.	Considerable burn on 4 plants on Dec. 1.
Gasteria angulata (Willd.) Haw.	2	90	8	do.	Nov.	
Gasteria brevifolia Haw.	2	90	2	do.	Nov.	
Gasteria carinata (Mill.) Haw.	2	90	16	do.	Nov.	

Table 1.--Continued

Plant name	Treatment: Dosage, Lbs.	Treatment: Duration, Min.	Number of plants	State of growth	Months tested	Remarks
Gasteria cheilophylla Baker	2	90	30	active	Nov.	
Gasteria excelsa Baker	2	90	400	do.	Nov.	
Gasteria maculata (Thunb.) Haw.	2	90	18	do.	Nov.	
Gasteria mollis Haw.	2	90	42	do.	Nov.	
Gasteria nitida (Salm-Dyck) Haw.	2	90	1	do.	Nov.	
Gasteria subnigricans (Sprong.) Haw,	2	90	10	do.	Nov.	
Gaultheria perplexa T. Kirk	2	90	45	do.	Feb.	
Do.	2.5	90	75	do.	Mar.	
Geum sp.	2	90	1	do.	Feb.	
Gleditsia sinensis Lam.	2	120	1	do.	Oct.	
Glottiphyllum sp.	2	90	3	do.	Nov.	
Griffinia hyacinthina Ker	2	90	2	dormant	Nov.-Jan.	
Guadua sp.	2	90	1	active	Jan.	Severe burn and defoliation.
Haemanthus Katherinae Baker	2	90	2	dormant	Nov.-Jan.	

Table 1.--Continued.

Plant name	Treatment: Dosage, Lbs.	Treatment: Duration, Min.	Number of plants	State of growth	Months tested	Remarks
Hamamelis virginiana L.	2	120	538	dormant	Jan.	
Haworthia angustifolia Haw.	2	90	112	active	Nov.	
Haworthia attenuata Haw	2	120	2	do.	Oct.	
Haworthia tortuosa pseudorigida (Salm-Dyck) Berger	2	120	2	do.	Sept.	
Hedera Helix flavescens Hort.	2	120	2	do.	Oct.	
Hedera Helix marmorata elegans Hort.	2.25	90	30	do.	Feb.	
Hedera Helix "New Bronze"	2.25	90	30	do.	Feb.	
Hedera Helix rhonboidea variegata Hort.	2.25	90	60	do.	Feb.	
Hedychium Ghalii Hort.	2	120	103	dormant	Dec.	
Hedychium Prudhonii Hort.	2	120	50	do.	Dec.	
Hedychium Sanderii Hort.	2	120	35	do.	Dec.	
Hedychium sp.	2	120	198	do.	Dec.	
Heurnia Thurcti Cels	2	150	4	do.	Sept.	
Do.	1	120	200	do.	Oct.	
Do.	2	120	200	do.	Oct.	

Table 1.--Continued.

Plant name	Treatment: Dosage, Lbs.	Treatment: Duration, Min.	Number of plants	State of growth	Months tested	Remarks
Hippeastrum aulicum robustum (A. Dietr.) Voss.	2	90	360	dormant	Nov.	
Hippeastrum decoratum Lem.	2	90	135	do.	Nov.	
Hippeastrum equestre (L. f.) Herb.	2.25	90	23	do.	Feb.	
Hippeastrum psittacinum (Ker) Herb.	2	120	3	active	Oct.	
Do.	2	90	200	do.	Nov.	
Do.	2.25	90	8	do.	Feb.	
Hippeastrum reginae (L.) Herb.	2.25	90	99	dormant	Feb.	
Hippeastrum rutilum creatum (Ker) Baker	2	90	175	active	Nov.	
Hippeastrum sp.	2	90	120	do.	Nov.	
Do.	2.25	90	28	do.	Feb.	
Hymenocallis festalis Hort. "Triumph"	2	90	1	active	Nov.	
Hymenocallis macrostephana Baker	2	90	1	do.	Nov.	
Hymenocallis speciosa (L. f.) Salisb.	2	90	2	do.	Nov.-dec.	
Hypericum oblongifolium Choisy	2.5	90	500	dormant	Mar.	

Table 1.--Continued.

Plant name	Treatment: Dosage, Lbs.	Treatment: Duration, Min.	Number of plants	State of growth	Months tested	Remarks
Hypericum sp.	2	120	186	dormant	Dec.	
Do.	2.5	90	1,500	do.	Mar.	
Do.	2.5	90	2,000	do.	Mar.	
Hypochoeris grandiflora Ledeb.	2	90	7	active	Feb.	
Ilex Cassine L.	2	90	100	do.	Nov.	
Ilex paraguariensis St. Hil.	2	90	10	do.	Nov.	
Ilex vomitoria Ait.	2	90	26	do.	Jan.	
Impatiens platypetala Lindl.	2	90	32	do.	Dec.	
Do.	2.5	90	30	do.	Apr.	
Incarvillea sp.	2	90	3	do.	Feb.	
Indigofera Gerardiana Hook.	2	120	329	dormant	Dec.	
Indigofera leptostachya DC	2	90	273	do.	Nov.-Jan.	
Do.	2.25	90	269	do.	Jan.	
Indigofera sp.	2	120	250	do.	Dec.	
Inodes exul O. F. Cook	2	90	16	active	Nov.	

Table 1.--Continued.

Plant name	Treatment: Dosage, Lbs.	Treatment: Duration, Min.	Number of plants	State of growth	Months tested	Remarks
Ipomoea cairica (L.) Sweet	2	90	179	active	Dec.-Jan.	
Jacaranda acutifolia Humb. & Bonpl.	2	120	98	do.	Sept.	Mature leaves lost.
Do.	2	150	54	do.	Sept.	All leaves dropped but plants released.
Jacaranda caucana Pittier	2	90	19	do.	Nov.	Refumigated. Feb. 9.
Jacaranda sp.	2	90	25	do.	Nov.	Do.
Jatropha podagrica Hook.	2	90	7	do.	Nov.	Refumigated 2 days later.
Do.	2	90	25	do.	Jan.	
Kalanchoe Blossfeldiana Poelln.	2	90	12	do.	Nov.	
Kalanchoe bracteata Scott-Elliot	2	90	12	do.	Nov.	
Kalanchoe Cassiopeia Damm.	2	90	2	do.	Nov.	
Kalanchoe crenata Haw.	2	120	5	do.	Sept.	
Kalanchoe glaucescens Britton	2	90	4	do.	Nov.	
Kalanchoe Hildebrandtii Baill.	2	90	7	do.	Nov.	Some defoliation.
Do.	2	120	2	do.	Sept.	Some burn and defoliation.

Table 1. Continued.

Plant name	Treatment: Dosage, Lbs.	Treatment: Duration, Min.	Number of plants	State of growth	Months tested	Remarks
Kalanchoe lanceolata (Forsk.) Pers.	2	90	85	active	Nov.	Some lower leaves burned.
Kalanchoe orgyalis Baker	2	90	10	do.	Nov.	Slight burn
Kalanchoe Schimperiana A. Rich.	2	90	61	do.	Nov.	
Kalanchoe Schumacheri Koord.	2	120	47	do.	Sept.	
Kalanchoe sexangularis N. E. Br.	2	90	5	do.	Nov.	
Kalanchoe somaliensis Hook. f.	2	90	1	do.	Nov.	
Kalanchoe synsepala Baker	2	120	8	do.	Sept.	Four plants badly burned and later died.
Kalanchoe thyrsiflora Harv.	2	90	25	do.	Nov.	
Kalanchoe velutina Welw.	2	120	5	do.	Sept.	Loss of mature leaves.
Kalanchoe Welwitschii Britton	2.5	90	8	do.	Apr.	
Kalanchoe spp.	2	120	259	do.	Sept.	Three species.
Do.	2	90	42	do.	Nov.	Three species.
Kitchingia peltata Baker	2	90	3	do.	Nov.	Slight burn on lower leaves.

Table 1.--Continued.

Plant name	Treatment: Dosage, Lbs.	Treatment: Duration, Min.	Number of plants	State of growth	Months tested	Remarks
Koelreuteria sp.	2	120	23	dormant	Dec.	
Leycestaria formosa Wall.	2	90	326	active	Nov.-Jan.	Refumigated in March.
Ligustrum amurense Carr.	2	120	236	dormant	Jan.	
Ligustrum sp.	2	120	48	do.	Jan.	
Linum sp.	2	120	2	active	Oct.	
Lobelia rosea Wall.	2	90	24	active	Nov.-Feb.	
Lobelia splendens Willd.	2.5	90	833	do.	Jan.	
Lonchocarpus Nicou (Aubl.) DC	2	90	1	do.	Feb.	
Lonchocarpus sp.	2	90	1	do.	Feb.	
Lonicera macrantha (D. Don) Sprang.	2.5	90	110	do.	Mar.	
Lonicera microphylla Willd.	2	120	655	dormant	Dec.	
Lonicera sp.	2	120	139	do.	Dec.	
Manihot esculenta Crantz	2	90	2	do.	Dec.	
Do.	2.5	90	9	active	Apr.	

Table 1.--Continued.

Plant name	Treatment: Dosage, Lbs.	Treatment: Duration, Min.	Number of plants	State of growth	Months tested	Remarks
Maurandya erubescens (D. Don) Gray	2	90	44	active	Feb.	
Do.	2.5	90	100	do.	Mar.	
Melastoma sp.	2	90	448	do.	Nov.-Feb.	No burn, but old growth was omitted in Nov. fumigations.
Mesembryanthemum acinaciforme L.	2	90	10	do.	Nov.	
Mesembryanthemum rigidicaule Haw.	2.5	90	5	do.	Apr.	
Mesembryanthemum sp.	2	90	9	do.	Nov.	
Monodora tenuifolia Benth.	2	90	1	do.	Dec.	
Musa paradisiaca L.	2	90	1	do.	Jan.	
Nathusia alata Hochst	2	90	60	do.	Feb.	
Do.	2.5	90	100	do.	Mar.	
Neanthe bella O. F. Cook	2.5	90	1,725	do.	Apr.	
Neanthe elegans (Hort.) O. F. Cook	2.5	90	45	do.	Apr.	
Neomarica gracilis (Herb.) Sprague	2	90	2	do.	Jan.	
Nerine humilis (Jacq.) Herb.	2.5	90	25	do.	Mar.	
Omanthe costaricana (Oerst.) O. F. Cook	2	90	14	do.	Nov.-Feb.	

Table 1.--Continued.

Plant name	Treatment: Dosage, Lbs.	Treatment: Duration, Min.	Number of plants	State of growth	Months tested	Remarks
Omanthe costaricana (Oerst.) O. F. Cook	2.5	90	190	active	Apr.	
Oncoba Routledgei Sprague	2	90	1	do.	Nov.	Considerable defoliation.
Opsiandra maya O. F. Cook	2	90	25	do.	Feb.	
Do.	2.5	90	25	do.	Mar.	
Opuntia spp.	2	90	8	do.	Nov.-Feb.	Two species.
Opuntia sp.	2.5	90	7	do.	Jan.	
Osbeckia crinita Benth.	2	90	185	do.	Feb.	
Pentas coccinea Stapf	2	90	65	do.	Feb.	
Do.	2.5	90	240	do.	Mar.	
Phaiocallis Herbertii (Herb.) Kuntze	2	90	18	do.	Feb.	
Philadelphus Delavayi Henry	2	120	1,059	dormant	Dec.	
x Philadelphus purpureo-maculatus Lemoine	2.25	90	30	active	Feb.	
Philadelphus spp.	2	120	712	dormant	Dec.	Six species.
Phillyrea decora Boiss. & Bal.	2.25	90	40	active	Feb.	
Phoenix rupicola T. Anders.	2	90	1	do.	Feb.	

Table 1. --Continued

Plant name	Treatment: Dosage, Lbs.	Treatment: Duration, Min.	Number of plants	State of growth	Months tested	Remarks
Pinckneya pubens Michx.	2	90	46	active	Nov.	
Pittosporum glabratum Lindl.	2	120	2	do.	Sept.	Mature leaves dropped.
Do.	2	90	14	do.	Nov.-Jan.	Mature leaves dropped. no injury to young growth.
Do.	2.5	90	16	do.	Jan.	Do.
Do.	2.5	90	400	do.	Apr.	Do.
Pittosporum rigidum Hook. f.	2	90	1	do.	Nov.	
Plectranthus sp.	2	120	2	do.	Sept.	
Do.	2	90	5	do.	Nov.	Tips burned.
Podocarpus Nagi (Thunb.) Pilger	2.25	90	1	do.	Feb.	
Podophyllum Emodi Wall.	2	120	135	dormant	Dec.	
Potentilla argyrophylla Wall.	2	90	30	active	Feb.	
Prosopis chilensis (Mol.) Stuntz	2	90	2	do.	Nov.	
Prosopis chilensis velutina (Wooton) Standl.	2	90	2	do.	Nov.	

Table 1.--Continued.

Plant name	Treatment: Dosage, Lbs.	Treatment: Duration, Min.	Number of plants	State of growth	Months tested	Remarks
Prunus cerasifera Ehrh.	2.25	90	100	dormant	Feb.	
Prunus Mahaleb L.	2.25	90	100	do.	Feb.	
Prunus tomentosa Thunb.	2	120	166	do.	Jan.	
Prunus sp.	2	90	1	active	Jan.	
Psidium Guajava L.	2	90	53	do.	Nov.	Slight tip burn
Pterocarya sp.	2	120	422	dormant	Dec.	
Ptychomphis augusta (Kurz) Becc.	2	90	75	active	Nov.	
Do.	2.5	90	43	do.	Apr.	
Pyracantha sp.	2.5	90	2	do.	Mar.	
Quercus sp.	2	90	56	do.	Feb.	
Do.	2.5	90	250	do.	Mar.	
Randia sp.	2	90	250	do.	Nov.	Refumigated with 2.5 lbs. in March.
Rhamnus sp.	2	90	28	do.	Feb.	
Do.	2.5	90	100	do.	Mar.	

Table 1.--Continued.

Plant name	Treatment: Dosage, Lbs.	Treatment: Duration, Min.	Number of plants	State of growth	Months tested	Remarks
Rhapidophyllum hystrix Wendl. & Drude	2.5	90	84	active	Apr.	
Rheum Ribes L.	2	90	10	do.	Feb.	
Rhododendron arboreum J. E. Sm.	2	90	72	do.	Feb.	
Do.	2.5	90	300	do.	Mar.	
Rhododendron chartophyllum Franch.	2.5	90	60	do.	Apr.	
Rhododendron Fortunei Lindl.	2.25	90	35	dormant	Feb.	
x Rhododendron malvatica Hort.	2.5	90	3	active	Apr.	
Rhododendron ovatum (Lindl.) Planch.	2.25	90	30	dormant	Feb.	
Rhododendron rufescens Franch.	2.5	90	42	active	Apr.	
Rhododendron Smirnowii Trautv.	2.5	90	26	do.	Apr.	
Rhododendron Tschonoskii Maxim.	2.5	90	56	do.	Apr.	
Rhododendron yunnanense Franch.	2.5	90	16	do.	Apr.	
Rhododendron sp.	2	120	2	do.	Sept.	
Rhododendron spp.	2.5	90	557	do.	Apr.	Three species.
Rhus sp.	2	120	60	dormant	Dec.	

Table 1.--Continued.

Plant name	Treatment: Dosage, Lbs.	Treatment: Duration, Min.	Number of plants	State of growth	Months tested	Remarks
Rollinia sp.	2	90	25	active	Nov.	
Roosveltia Franklinicna O. F. Cook	2.5	90	660	do.	Apr.	
Rosa amblyotis Hey.	2	120	23	dormant	Dec.	
Rosa Beggeriana Schrenk	2	120	206	do.	Dec.	
Rosa Drummii Lindl.	2	120	93	do.	Dec.	
Rosa cymosa Tratt.	2	120	82	do.	Dec.	
Rosa glauca Vill.	2	120	1	do.	Dec.	
Rosa moschata Desf.	2	120	57	do.	Dec.	
Rosa omeiensis Rolfe	2	120	38	do.	Dec.	
Rosa turkestanica Regel	2	120	1	do.	Dec.	
Rosa tuschetica Boiss.	2	120	15	do.	Dec.	
Rosa spp.	2	120	4,000	do.	Dec.	73 species
Rubus affinis Weithe & Nees	2.5	90	3	active	Jan.	
Rubus Bertramii G. Braun	2.5	90	1	do.	Jan.	
Rubus cissburiensis Barton & Riddelsd.	2	90	6	do.	Feb.	

Table 1.--Continued.

Plant name	Treatment: Dosage, Lbs.	Treatment: Duration, Min.	Number of plants	State of growth	Months tested	Remarks
Rubus ellipticus J. E. Sm.	2	90	17	active	Feb.	
Rubus hirtus Waldst. & Kit.	2	90	17	do.	Feb.	
Rubus infectus Weihe	2	90	14	do.	Feb.	
Rubus Lambertianus Seringe	2	120	1	do.	Oct.	
Rubus nitidioides W. Wats.	2.5	90	1	do.	Jan.	
Rubus rhamnifolius Weihe	2	90	17	do.	Feb.	
Rubus roseaceus Weihe & Nees	2.5	90	2	do.	Jan.	
Do.	2	90	25	do.	Feb.	
Rubus thyrsiflorus Weihe & Nees	2	90	17	do.	Feb.	
x Rubus thyrsiger Banning & Focke	2.5	90	2	do.	Jan.	
Do.	2	90	13	do.	Feb.	
Rubus ulmifolius Schott	2	90	16	do.	Feb.	
Rubus ulmifolius inermis (Wild.) Focke	2.5	90	1	do.	Jan.	
Rubus sp.	2	90	4	do.	Feb.	
Rubus "John Innes"	2.5	90	2	do.	Jan.	

Table 1.--Continued.

Plant name	Treatment: Dosage Lbs.	Treatment: Duration Min.	Number of plants	State of growth	Months tested	Remarks
Sabal sp.	2	90	84	active	Nov.	
Do.	2.5	90	5	do.	Apr.	
Sapindus Mukorossi Gaertn.	2	90	1	do.	Nov.	
Sarcococca Hookeriana Baill.	2	120	9	do.	Sept.	
Do.	1.5	120	438	do.	Oct.	
Do.	2	90	440	do.	Jan.	Same lot refumigated
Do.	2.5	90	440	do.	Mar.	
Sarcococca Hookeriana humilis (Stapf) Rehd. & Wils.	2	120	17	do.	Sept.	
Sarcococca ruscifolia Stapf	2	120	9	do.	Sept.	
Sarcococca saligna (D. Don) Muell. Arg.	2	120	4	do.	Sept.	
Scorzonera sp.	2	90	1	do.	Feb.	
Senecarpus sp.	2	90	2	do.	Nov.	
Sempervivum glutinosum Ait.	2	90	2	do.	Nov.	
Senecio crassissimus Humbert	2	90	25	do.	Nov.	
Senecio salignus DC	2	90	346	do.	Jan.-Feb.	

Table 1.--Continued.

Plant name	Treatment: Dosage, Lbs.	Treatment: Duration, Min.	Number of plants	State of growth	Months tested	Remarks
Skimmia japonica Thunb.	1	120	8	active	Nov.	
Do.	2	90	1	do.	Nov.	
Skimmia japonica Veitchii (Carr.) Rehd.	2	90	2	do.	Oct.	One plant defoliated
Skimmia Reevesiana Fort.	2	90	1	do.	Feb.	
Solanum sp.	2.5	90	7	do.	Jan.	
Spiraea canescens D. Don	2	120	624	dormant	Dec.	
Spiraea spp.	2	120	1,980	do.	Dec.	Five species.
Stapelia ambigua Mass.	2	90	140	active	Nov.	
Stapelia cantabrigiensis Berger	2	120	2	do.	Sept.	
Stapelia flavirostris N. E. Br.	2	90	9	do.	Nov.	
Stapelia nobilis N. E. Br.	2	120	2	do.	Sept.	
Stapelia sp.	2	90	21	do.	Nov.	
Stenomesson variegatum (R. & P.) Macbr.	2	90	10	do.	Nov.	
Strelitzia reginae Banks	2	90	1	do.	Feb.	
Sycopsis sinensis Oliv.	2.5	90	250	do.	Mar.	

Table 1.--Continued.

	Treatment		Number of plants	State of growth	Months tested	Remarks
	Dosage, Lbs.	Duration, Min.				
Syringa sp.	2	120	142	dormant	Jan.	
Thalictrum Rochebrunnianum Franch. & Sav.	2	120	789	do.	Dec.	
Theobroma purpureum Pittier	2	90	3	active	Nov.	Considerable tip burn.
Troma sp.	2	120	2	do.	Oct.	
Do.	1.5	120	156	do.	Nov.	
Do.	2	90	173	do.	Nov.	

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